

Fresno, Cal.: No unusual phenomenon of this character was observed until after November 10, 1912. On this date a very good general rain occurred and cleared the atmosphere of the dust, which gives it a very hazy appearance during the dry season. During the remainder of November a number of very beautiful sunsets were observed, which differed from the usual phenomenon in that the brilliant colorings were more widely and more evenly diffused than is common. Approximately 120° of the western horizon was colored, the hues reaching well toward the zenith and continuing with a brilliance more or less noticeable for fully an hour after sunset. The duration was an especial feature of the phenomenon. The reds were most conspicuous, but other colors in that portion of the spectrum, the yellows and oranges, which appeared first in order, were not much less so.

Santa Fe, N. Mex., December 29, 1912: The sunset glow this evening was especially brilliant. By 5.10 p. m. the entire western sky was rosy from 110° north to 90° south of the sunset point, and upward fully 65°. By 5.20 p. m. the colors had become brilliant red about the sunset point, shading off to a beautiful rosy red in the distance. By 5.30 p. m. the lower colors had become dark red and very brilliant. Thereafter the colors faded rapidly, and the last glow was seen at 6.10 p. m.

In the following letter, which is a reply to circular letter of December 28, 1912, attention is called to the well-known fact that brilliant twilight colors are only observed under favorable meteorological conditions:

During the summer of 1911 I spent from June 12 until September 1 in Prince Edward Island, Canada. Almost the entire summer there were brilliant pink sunsets that were very similar to those in the autumn of 1883. Previous experience in that region shows that brilliant afterglow sunsets may be expected in summer.

In 1912, from June 5 until September 7, I saw no afterglow that was brilliant, and only a few that were slightly reddish. The weather was unusually damp for the region all summer.

It would appear that the amount of moisture must have had some relation to the absence of the afterglow of the sunsets in 1912 in the above region.—Prof. C. C. TROWBRIDGE, Department of Physics, Columbia University, New York City.

There seems to be good evidence that unusually brilliant red sunsets were observed in the United States during the fall of 1912, and especially in November, and in the drier sections of the country, where conditions were especially favorable for such observations. It does not appear that the twilight colors have been markedly different from those of other years except for an increase in intensity, and in some cases an increase in duration. While the purple or rose-colored glow that has been observed to overspread the sky a short time after sunset or previous to sunrise has been a prominent feature of the displays, it has not been comparable with the afterglows observed in 1883.

*Atmospheric turbidity in Europe in 1912.*—The reader is referred to the scientific journals<sup>2</sup> for details of the many observations that indicate decreased atmospheric transparency in Europe during the latter part of 1912. Nearly all the writers fix the date of the first appearance of the haze between June 20 and 27; Dr. L. Steiner, however, finds evidence of unusually hazy conditions as early as May, 1912, which were intermittent in character and appeared to be connected with anticyclonic weather conditions. The intensity of the haze appeared to increase with each recurrence, until a maximum was attained in July.

In his reply to circular letter of December 28, 1912, Dr. Adolf Hnatek, of the Vienna Astronomical Observatory, places the first appearance of the haze previous to June

12. He states that since two photographic-photometric exposures on the constellation Coma Berenices, one on June 12, of 80 minutes, and the other on June 19, of 90 minutes, failed to show stars revealed by an exposure of an hour on June 3, the disturbance in the atmosphere may have had its commencement between June 6 and 12. He estimated the decrease in atmospheric transmissibility at from 10 to 15 per cent.

Observations from high Alpine peaks and from balloons indicate that the haze was confined to great heights. It seems to have diminished greatly by November, 1912, although some observers saw evidence of it at the end of the year.

*Summary.*—The eruption of Katmai Volcano, on June 6, 1912, was followed by a fall of volcanic ash over all of southeastern Alaska and southward into the State of Washington.

A hazy or smoky condition of the atmosphere that was first observed in the United States from June 8 to 10, but apparently did not reach its maximum intensity until June 20 to 25, was also observed in Europe and in northern Africa. In Europe it was not generally observed until after June 20, although there is evidence that it may have been present previous to June 12. In Algeria, northern Africa, there is evidence that it was present as early as June 19.

Astronomical observations, and especially astronomical photography, together with pyrheliometric measurements and records from sunshine recorders, indicate that the haze caused a marked decrease in atmospheric transparency.

Twilight colors in the United States during the fall of 1912 were more brilliant than usual and perhaps also of greater duration. The red shades were especially pronounced.

At the end of 1912 the haziness appeared to be decreasing.

#### MOUNTAIN SNOWFALL MEASUREMENTS.

By BENJAMIN C. KADEL, Local Forecaster, Weather Bureau.

As the irrigation systems of the country increase, the need of more accurate measurements of the water supply from the mountain snow fields becomes greater. An experience of two years' actual work in the snow fields of a portion of the Rio Grande National Forest in Mineral County, Colo., at elevations exceeding 9,000 feet, has demonstrated that the problem is not so complicated as it may appear to the casual visitor to the mountains. The apparent confusion in the distribution of the snow layer, here the bare hillside, there the deep even layer of the forest, and beyond the great timber line drifts, is, upon closer acquaintance, found to be the result of natural causes, the most important of which is the angle the slope, on which the snow lies, makes with the sun. In the high regions of the mountains the sun shines for a greater number of hours during the winter than at lower elevations because the sky is less frequently obscured by cloud, and the sun's rays are also stronger, because they

<sup>1</sup> The eruption of Krakatoa and subsequent phenomena. Report of the Krakatoa committee of the Royal Society, p. 340, and frontispiece.

<sup>2</sup> Wolf, M. Trübung der Atmosphäre und Dämmerungserscheinungen. Met. Zeit., July, 1912, Bd. 29, p. 339.

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shine through a rarer atmosphere. Actual measurements show that on south slopes the main body of the snow generally melts within a few days after it falls, even though thermometers exposed a few feet above the ground show temperatures well below the freezing point. From the fact that the main body of the snow that falls on south slopes disappears time and again during the course of a winter, while at the same time the mountain streams continue at low stage, it seems reasonable to conclude that the greater portion of the snow that falls on these slopes is evaporated, and hence is of little importance in maintaining the summer water supply. It is therefore useless to place any measuring devices on south slopes, because such measurements are of temporary conditions that will have little or no relation to the spring water supply. In striking contrast, snow lying on north slopes shows little or no melting until the advent of the higher temperatures of April, and even then the north slope snow first melts into itself, without important loss of water value. Another important fact is that snow does not drift on timbered north slopes, and there is but little loss by evaporation on these slopes. Actual measurements have shown that the water value of the snow on the ground on north slopes in the spring may be as much as 20 per cent greater than the total catch of the winter in gages so located that they are practically shielded gages. Since we have the accumulated snows of the winter available for measurement at any time before the spring thaw, such apparatus as gages, bins, and other devices for catching the snow as it falls are not only useless but misleading, first because of their well known failure to make a correct catch, and second because they hold their contained snow up to the action of sun and wind, thus accelerating the evaporation of their contents. Since it has been demonstrated that the entire accumulation of the winter's snowfall may frequently remain on the north slopes, then it follows that we have in these slopes the key to the problem. At the same time the snow lying on east and west slopes, which may enter the earlier spring flood, and also the quantity of snow above timber line must bear a close relation to that on the north slopes from year to year. When the area under study is limited in extent, it is possible to make a good working estimate of the total water value of the snow on the entire area by measuring each representative slope separately, and then combining the results by weighting each measurement according to the area it represents. It is obviously erroneous to use an average of a number of measurements for any purpose, unless all were made on slopes of practically the same degree of angle and orientation. To make a detailed snow survey of large areas generally involves a better knowledge of the contour of the field than ordinary maps afford, and it is probably better to confine the work to the north slopes, and to base estimates of water supply on a comparison of the year under consideration with previous years.

The best place for making measurements is on a north slope of about 20° in an open space in a stand of timber. A slight variation from north will have but little effect, though a northeasterly slope is better than a northwesterly one, but in general the slope should be as near to true north as possible. The ideal timber location is in small hardwood, such as aspen, whose trunks are close enough to prevent drifts, and whose crowns are insignificant, while nearness to large coniferous trees should be avoided. Surroundings should also be considered, since open parks of great extent may be responsible for large accretions of snow, particularly near the timber line. Such locations are to be avoided.

In order to measure the water value of a given snow layer it is required to know both the depth and the density of the layer. The accepted method of measuring the depth is by means of snow scales, permanently fixed, from which the depth may be read at any time. The scale should be as small in cross section as practicable, so as to reduce reflected heat and consequent melting of the snow immediately about it, and at the same time it must be large enough for graduations that may be read at some distance, say 25 feet or more. It has been found satisfactory in practice to use a vertical staff, 1½ inches square and 10 feet long, secured in a vertical position. The staff is first painted white, after which the graduations are painted on with a quick-drying black paint, the foot numbers on one face, and the tenths of feet on the adjacent face, the tenths being made recognizable by wide triangles at the foot marks, narrow triangles at the half-foot, and triangles that reach only half across the staff at the intermediate tenths. A scale so graduated may be read at 200 feet with the aid of a small field glass. The increased legibility gained by graduating the scale in feet and tenths more than repays the work involved in translating the readings in to inches, since it permits the observer to make the readings without disturbing the snow near the scale, and also allows scales to be located at points inaccessible on snowshoes, but within reading distance of some accessible point. The scale may be set up by first nailing the zero end of the staff into a halved-out block of wood, then setting the whole into the ground to bring the zero to the ground surface, then securing by guy wires to stakes or other rigid supports.

The density of the snow layer has been measured by means of tubes of small bore, with the lower rim filed into saw teeth, which in actual practice are either thrust down through the snow layer to the ground, or in some cases rotated as they descend. The tube is then withdrawn and the snow found in it is considered a representative sample of the layer. In actual practice it is frequently found that when, under extremely dry, cold conditions, it is possible to cut out a correct sample; the snow core will drop from the tube as it is withdrawn, while snow that is moist enough to resist dropping out of the tube will also resist entering the tube; therefore a correct sample can not always be obtained. The upper layers of snow are tough and matted together, while from a point several inches below the surface downward to the ground it is dry and granular. The top layer frequently forms into a conical stopper that effectively pushes the dry, granular lower layers aside as the tube proceeds downward. This action may easily be determined by comparing the height of the snow inside the tube with the height outside. In narrow-bore tubes it will be found that the snow is much lower in the tube than the surrounding layer, while if a section be bounded by a larger tube, say a 6-inch stove-pipe, the snow within the tube will remain almost as high as outside. The decided advantage thus gained has led to the use of tubes 5.94 inches in diameter, so chosen to make 1 pound of snow equal to 1 inch of water in the tube for convenience in making the computations. Such tubes can be made at any tin shop. The seam should be drawn and riveted with small rivets. Sixteen-gauge iron is necessary to give the strength required for the dense upper layers in late spring. The tube may be made in sections, and joined by a notched collar, so as to be available for various depths. After the tube has been inserted through the snow layer, an auger, whose diameter is a little less than the tube, is screwed down through the imprisoned snow, a cross pin 8 inches long through a hole in the handle at the upper rim of the tube serving to prevent

the auger from boring into the ground, and also supporting the weight of the contained snow when the tube is withdrawn. The auger may be made by attaching a circular piece of 16-gauge iron to a wood handle with corner braces, then cutting on the diameter from opposite sides to the handle, and finally bending the edges of the cut to the desired shape. The snow sample may then be emptied into a light-weight receptacle—a 5-gallon oil can serves well—and weighed. Spring balances sold under the trade name "Dairy Scales," which are graduated in pounds and tenths on a dial, and have a capacity of 24 pounds, are suitable for this purpose and may be purchased almost anywhere. When the matted upper layer of snow is of considerable depth, as occurs under the bright sunshine of March and April, it is necessary to take out a few inches at a time, and reinsert the tube in the same hole until the granular layer is reached. The tough upper-layer snow will stick in the tube so that it may be removed without the support of the auger. If not taken out a little at a time it will clog even the large tube. The observer will learn by practice how best to meet this condition, although to pass from the tough upper layer to the dry granular snow remains the weak point in the problem of bounding a section of the snow layer.

The net weight of the sample in pounds gives the water equivalent in inches, but since density measurements must be made at right angles to the ground to prevent the escape of snow through the lower end of the tube when the auger is screwed down, it is best to compute the density from the weight and depth, and apply the factor thus determined to the vertical scale readings. Since the measurements used in surveys are horizontal, it is best to use the vertical values. For example, if the depth at right angles to the ground is 26 inches, and the weight of the sample in the 5.94-inch tube is 5.2 pounds, then the density is  $5.2 \div 26 = 20$  per cent; and if the vertical depth as read from the snow scale is 30 inches, then the water equivalent of the snow layer is 20 per cent of 30 inches, or 6 inches. This value, multiplied by the area of the slope as scaled from a map, will give the cubic water content of the slope.

The density measurements should be made at some distance from the scale so that conditions at that point may not be disturbed. It is well to select the place for the density measurements before the first snow, clear the ground, and stretch a wire across for a marker. A rag fastened to the wire with a clothespin serves to mark the place at which the snow has been disturbed, so that subsequent measurements may be made at a different place even though a new snow may have fallen.

The methods and apparatus here described are the result of actual experience with snow up to 5 feet depth. The appliances can be readily secured almost anywhere, and while the values found by their use are far from refined, yet in the region where they have been used they furnish a reliable working basis for both comparative and quantitative measurements. The weight of the large tube unfortunately renders it difficult to carry about, but the cost is small enough to permit an equipment at each measuring station. In the hands of expert toolmakers, the appliances could no doubt be greatly refined.

#### INTERESTING SOLAR HALO.

By FREDERICK SLOCUM, Assistant at the Yerkes Observatory, Williams Bay, Wis.

Between noon and 1 p. m. (central standard time) May 19, 1910, solar halos were observed and also streaks and patches of brilliant colors, some resembling fragments of

a rainbow and others isolated patches of approximately monochromatic colors, rose, pink, green, blue, etc., while some showed iridescent or iris effects. These appeared in the south at an altitude of  $15^{\circ}$  to  $20^{\circ}$ .

At the time, great masses of cumulus clouds were slowly drifting from the west. Back of the cumulus were brush-like formations of cirrus. The colors were sometimes projected on the cirrus, and sometimes on what was apparently clear sky. A photograph taken at 12 hours and 10 minutes, central standard time, looking directly south from the roof of the observatory with a 4" x 5" camera, a color filter and an isochromatic plate, shows the cloud formation, also a horizontal streak where a strip of rainbow colors occurred, and also a brilliant patch of iridescent or iris cloud. The above phenomenon was observed by eight others of the observatory staff and the writer (i. e., Messrs. Frost, Burnham, Barnard, Parkhurst, Barrett, Lee, Mitchell, and Slocum), no one of whom had before seen similar effects.

NOTE.—Those were the days when Halley's comet was being anxiously expected to pass near the earth, and the sky was being carefully scrutinized owing to the possibility that some unusual terrestrial phenomenon might occur. As a result of this careful scrutiny it is generally believed that nothing unusual occurred in the atmosphere of the earth, and we must therefore consider the patches and streaks of brilliant colors seen at Williams Bay to be fragments of ordinary solar halos due to the presence of ice crystals or snow in the cirrus formations back of and higher than the cumulus clouds. A complete description of all forms of halos is given in the *Meteorologische Optike* of Pernter and Exner, published at Vienna during the years 1902–1910, in memory of the first 50 years of activity of the K. K. Central Institute for Meteorology and Terrestrial Magnetism. The colored patches observed by Mr. Slocum seem to correspond closely with the location of the circular halo of about  $22^{\circ}$  radius that surrounds the sun, and is due to the presence of small prismatic crystals of ice. On page 312, Pernter says the parheliion of  $22^{\circ}$  distance from the sun is explained by the direct passage of solar rays through vertical ice prisms whose refracting angle is  $60^{\circ}$ , and whose refracting edges are perpendicular to the observer's horizon as they float in the atmosphere. On page 320, Pernter says the parheliion, therefore, differs from the halo of  $20^{\circ}$  in the fact that the latter being a closed ring around the sun is due to such prisms of ice as have every possible orientation. . . . The measurements of the distance of the ring from the sun confirms this conclusion to the minutest details.

#### METEOROLOGY IN THE FAR EAST.

(Extract from the Scientific American of February 15, 1913.)

At the suggestion of Prof. Nakamura, in charge of the meteorological service of Japan, there will soon be held a meeting of the directors of meteorological observatories in the Far East, the first assembly of its kind. Practical meteorology has made great progress in that part of the world in recent years. Notable steps have been the extension of the Philippine Weather Bureau to outlying islands favorably situated for keeping track of typhoons; the organization of a complete meteorological service in Indo-China; the establishment of a telegraphic weather service along the whole China coast, and to a rapidly growing extent, in the interior of China, under the Zikawei Observatory, at Shanghai; the creation by the Germans of a local service for Kiao-chau, with headquarters at Tsingtao; and the organization of an excellent service in Korea,